Mathematical Functions

QuickDraw GX provides mathematical functions for

- fixed-point operations on `Fixed`, `long`, and `fract` number formats
- fixed-point operations on a `wide` number format
- vector operations
- Cartesian and polar coordinate point conversions
- random number generation
- linear and quadratic roots
- bit analysis

A description of each QuickDraw GX mathematics function is provided in the section "Mathematical Functions" beginning on page 8-42.

Operations on Fixed, long, and fract Numbers

QuickDraw GX provides functions that perform operations on `Fixed`, `long`, and `fract` number formats. Functions are provided that

- determine the product of two numbers (a b)
- determine the quotient of two numbers (a / b)
- determine the product of two numbers and the quotient of a third number (a b) / c
- determine both the sine and cosine of an angle measured in degrees [sine(angle) and cosine(angle)]
- determine the square root of a number (a)*1/2*
- determine the cube root of a number (a)*1/3*
- determine the magnitude of a two-dimensional vector

The functions that perform operations on `Fixed`, `long`, and `fract` number formats are described in the section "Fixed-Point Operations" beginning on page 8-42.

Operations on wide Numbers

QuickDraw GX provides functions for operations on `wide` numbers. Functions are provided that

- determine the sum of two `wide` numbers (a + b)
- determine the difference between two `wide` numbers (a - b)

- determine the product, as a `wide` number, of two `long` numbers (a b)
- determine the quotient, as a `long` number (without remainder), of a `wide` number divided by a `long` number (a / b)
- determine the result, as a `long` quotient and a `long` remainder, of dividing a `wide` number by a `long` number (a / b + remainder)
- determine the square root of a `wide` number (a)*1/2*
- negate a `wide` number (-a)
- shift bits in a `wide` number to the right or left
- determine the highest order bit in the absolute value of a `wide` number
- compare two `wide` numbers

The functions that perform operations on `wide` number formats are described in the section "Operations on wide Numbers" beginning on page 8-49.

Vector Operations

QuickDraw GX provides vector operation functions that

- determine the dot product of two vectors (v*1* v*2*)
- determine the dot product of two vectors and divide by a number (v*1* v*2*)/a

The use of QuickDraw GX vector operation functions is described in the section "Performing Vector Operations" beginning on page 8-29. These functions are described in the section "Vector Operations" beginning on page 8-54.

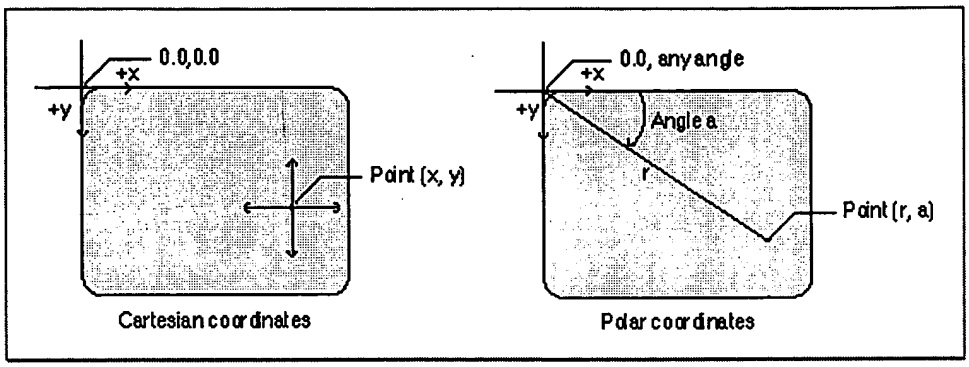
Cartesian and Polar Coordinate Conversion

You use Cartesian coordinates to specify points with QuickDraw GX. Some shapes, such as rectangles, are more easily drawn using Cartesian coordinates; however, some shapes that have symmetry about a point are more easily drawn with polar coordinates. For that reason, QuickDraw GX provides conversion routines so that you can work in either coordinate system.

For QuickDraw GX, **Cartesian coordinates** have a positive *x* direction to the right and a positive *y* direction downward (not upward, as in many other Cartesian coordinate systems). Cartesian coordinates are written in the order (*x*, *y*). The origin is at (0, 0). The `gxPoint` structure describes points using Cartesian coordinates.

Polar coordinates have the same origin point as Cartesian coordinates, but locations are specified differently. The polar coordinate of a point is specified by the length of the radius vector *r* from the origin to the point and the direction of the vector is specified by polar angle *a*. Angles in QuickDraw GX are measured clockwise in degrees from the Cartesian coordinate positive x-axis. The polar coordinate of a point specified by a vector of length *r* and direction *a* degrees from the x-axis is written as point (*r*, *a*). The polar origin point has the coordinates (0, *a*), where *a* is any angle. Points having polar coordinates are defined by the `gxPolar` structure. The `gxPolar` structure is described in the section "Constants and Data Types" beginning on page 8-35. The relationship of the Cartesian and polar coordinates is shown in Figure 8-1.

Figure 8-1 Cartesian and polar coordinates



The `gxPolar` location (*r, a*) corresponds to the `gxPoint` location ($r \cos(a)$, $r \sin(a)$). The mathematical relationship between the two coordinate systems is given by the expressions $r2 = x2 + y2$ and $\tan(a / 2) = y / (r + x)$. The angle can also be defined by the more familiar term $\tan(a) = y / x$.

The use of the polar-to-Cartesian and Cartesian-to-polar coordinates functions are described in the section "Converting Between Cartesian and Polar Coordinates" beginning on page 8-29. These functions are described in the section "Cartesian and Polar Coordinate Point Conversions" beginning on page 8-56.

Random Number Generation

The QuickDraw GX random-number algorithm generates random integers in the range of 0 to 2*count* - 1, where *count* is the number of bits to be generated by the random number generator.

The sequence of values that the random number generator produces is dependent upon the initialization value called the **seed**. The algorithm uses the seed to calculate the next random number and a new seed. If no seed is provided, QuickDraw GX uses a default seed value of 0. To repeat a sequence of random numbers, you can use the same seed value.

QuickDraw GX provides random number generation functions that

- generate a sequence of random bits
- change the seed used by the random number algorithm
- determine the current seed for the random number algorithm

The use of the random number generation functions is described in the section "Generating Random Numbers" beginning on page 8-33. These functions are described in the section "Random Number Generation" beginning on page 8-58.

Roots of Linear and Quadratic Equations

QuickDraw GX provides mathematical functions that

- determine the root of a linear equation
- determine the roots of a quadratic equation

The linear and quadratic equation solving functions are described in the section "Linear and

Quadratic Roots" beginning on page 8-60.

Bit Analysis

QuickDraw GX provides a mathematical function that allows you to determine the highest bit number that is set in a number.

The `FirstBit` function is described in the section "Bit Analysis" beginning on page 8-62.

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